

Health Consultation

Past Exposure to Drinking Water from
On-Base Wells 313 and 314

KELLY AIR FORCE BASE

SAN ANTONIO, BEXAR COUNTY, TEXAS

EPA FACILITY ID: TX251724333

JUNE 1, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

Atlanta, Georgia 30333

HEALTH CONSULTATION

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Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

PURPOSE AND SUMMARY

The purpose of this health consultation is to determine the likelihood of adverse health effects from drinking water obtained from Kelly Air Force Base on-base Wells 313 and 314. This consultation is Phase III of a three-phase process for evaluating the public health at Kelly Air Force Base. Phase III is divided into two parts: this health consultation and a public health assessment for East Kelly. The East Kelly assessment is being completed as a separate document. Phase I of this process was completed on August 20, 1999, with issuance of the public health assessment for Kelly Air Force Base (AFB). Phase II addresses air emissions and will be completed as a separate document.

The Restoration Advisory Board became concerned about water from on-base Wells 313 and 314 when a connection from the contaminated shallow aquifer to Well 313 was rediscovered in 1999. The connection was originally found in June 1989. Well 314 is located adjacent to Well 313, and was connected to Well 313 in the past. Details of the wells, the sampling, and discussion of the public health implications are provided in the next four sections. *In summary, ATSDR concludes that past exposure from ingestion of water from Well 313 and Well 314 is not an apparent public health hazard because the concentrations of chemicals in the water combined with the length of estimated exposures were low.*

INTRODUCTION

In this health consultation, ATSDR presents its evaluation of exposure and potential health effects from consuming water from Wells 313 and 314. This consultation is organized into four sections: Background, Data Evaluation and Interpretation, Public Health Implications, and Public Health Action Plan. In the Background section, ATSDR discusses the pertinent environmental conditions and existing data. In the Data Evaluation and Interpretation section, the existing data is evaluated, and the concentrations people may have been exposed to is calculated. In the Public Health Implications section, ATSDR presents its final conclusions. Last, the Public Health Action Plan section discusses the activities Kelly AFB completed in the past and the activities the base is currently conducting to protect public health related to the drinking water. This last section also includes ATSDR's recommendations.

BACKGROUND

The following pertinent environmental conditions and existing data are presented and discussed in this section.

- The groundwater below Kelly AFB
- Groundwater contamination in the shallow aquifer
- On-base drinking water supply and distribution system
- Groundwater from the shallow aquifer flowing into Well 313

Groundwater below Kelly AFB

Groundwater below Kelly AFB is found in two main geologic zones (see Figure 1). These zones are called the shallow aquifer and the Edwards aquifer. The top of the shallow aquifer is found at depths 3 to 37 feet below ground surface across Kelly AFB with a thickness varying from 0 to 20 feet. The shallow aquifer generally exists as an unconfined, water table aquifer. This means that water may flow freely from the ground surface into the shallow aquifer. Below the shallow aquifer are seven different layers of clay and rock. These layers prevent the shallow aquifer from flowing deeper into the ground.

The second main water-bearing zone below Kelly AFB is the Edwards aquifer. The Edwards aquifer below Kelly AFB is approximately 1,500 feet below the ground surface and slopes to the surface northwest of San Antonio in an area known as the Balcones fault zone. Water enters (recharges) the Edwards aquifer in the Balcones fault zone via runoff from rain and from the bottom of rivers (CH₂M Hill 1996). Under natural conditions, the Edwards aquifer is not connected to the shallow aquifer below Kelly AFB. Hence, surface water does not naturally flow into the Edwards aquifer below Kelly AFB. More information about the Edwards aquifer is provided in Appendix D.

The Edwards aquifer is the source of water for about 1.3 million people (as of 1997) in and near San Antonio and for ranches and farms in the region. The aquifer yields large quantities of water to wells and springs (United States Geological Survey 1997). The San Antonio metropolitan area is one of the largest cities in the United States to rely on groundwater (mainly from the

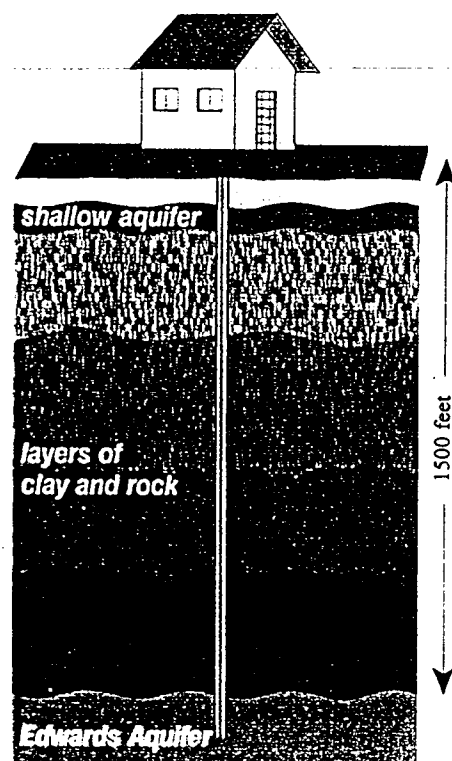


Figure 1. Simplified view of geology below Kelly AFB.

Edwards aquifer) for its principal water source.

According to the Texas Water Development Board well database (data obtained from their website in February 2000), there are 1,116 wells and springs in Bexar County (Figure 2). Of these, 1,057 are used to withdraw water and 59 wells are used for oil or gas, mines, or groundwater observations. The 1,057 wells and springs are used for various purposes including commercial, domestic, irrigation, industrial, medicinal, public supply, aquaculture, stock, and institutions. Of these 1,057 wells, 943 tap into the Edwards aquifer. While this well inventory is not 100% accurate, it provides general information about the widespread use of the Edwards aquifer in Bexar County.

Groundwater contamination in the shallow aquifer

Water in the shallow aquifer below Kelly AFB is contaminated with chemicals from Kelly AFB and possibly other sources. The contamination from Kelly AFB is the result of past spills and releases which included solvents, fuels, and other organic chemicals. The area surrounding Kelly AFB is or was used for farming and industry, automotive repair shops, dry cleaners, and paint shops. ATSDR reviewed the shallow groundwater data because the shallow aquifer is the most likely source of contamination to Well 313. However, it is possible that contamination could enter the Edwards aquifer from the recharge area.

Kelly AFB investigated the groundwater contamination in the shallow aquifer by grouping the base into five areas called zones. Wells 313 and 314 are located in Zone 3. To investigate the groundwater contamination in Zone 3, Kelly AFB installed 214 monitoring and temporary wells under the Department of Defense's Installation Restoration Program (IRP). Figure 3 shows Wells 313 and 314 and the adjacent IRP monitoring wells. Two IRP monitoring wells are located within 50 feet of Wells 313 and 314. Data from these two IRP monitoring wells and others in the vicinity indicate that groundwater near Wells 313 and 314 contain tetrachloroethene at 100 micrograms per liter ($\mu\text{g/L}$) and trichloroethene at 10 $\mu\text{g/L}$ (Figure 3). ATSDR used the data from the IRP monitoring wells in the following exposure assessment discussion as a worst case scenario. The highest concentrations of tetrachloroethene and trichloroethene in Wells 313 and 314 were 5.5 $\mu\text{g/L}$ and 2.8 $\mu\text{g/L}$, respectively in Well 313 and <0.5 $\mu\text{g/L}$ and <0.5 $\mu\text{g/L}$, respectively in Well 314.

On-base drinking water supply and distribution system

At Kelly AFB, records indicate that 21 wells tap into the Edwards aquifer currently or in the past (SAIC 1996, 1997, Griffith no date). Twelve of these wells, including Wells 313 and 314, are used or have been used for drinking water and industrial production; six are currently active. The other nine wells have mostly been used for irrigation. Wells 313 and 314 were permanently

the water from the Edwards aquifer into the horizontal pipe and to the pumps. The pumps pushed the water into the distribution system. Sometime in the 1970s, these pumps were removed and new pumps were installed in each well (Figure 5). At this same time, plugs were installed in the horizontal pipe. The new pumps then pumped water from the wells into the distribution system, bypassing the horizontal pipe.

Under natural conditions, the water from the shallow aquifer is not connected to the Edwards aquifer. However, if a leak occurred in the horizontal pipe and the plug, a connection could be established. Water could then flow between the well and the shallow aquifer. The direction of the flow would depend on the relative water levels of the shallow aquifer and the Edwards aquifer. If the well water level from the Edwards aquifer was below the water level of the top of the shallow aquifer, water from the shallow aquifer would leak into the horizontal pipe and the Edwards aquifer well (Figure 6). Conversely, if the well water level from the Edwards aquifer were above the water level of the top of the shallow aquifer, water from the Edwards aquifer well would leak into the shallow aquifer (Figure 7). Therefore, the relative water levels are important for determining how long the contaminated water could have been flowing into Well 313.

The water level of the Edwards aquifer at Kelly AFB rises and falls based on the amount of recharge and the amount withdrawn. Similarly, the water level in the shallow aquifer also rises and falls with time, based on rainfall. For the shallow aquifer, water level data is available from Kelly AFB from the two IRP monitoring wells located near Wells 313 and 314 (Figure 3). For the Edwards aquifer, water level readings are available from the San Antonio Water System (SAWS) Edwards Monitoring Well No. J-17 and other wells in the Texas Water Development database. ATSDR reviewed data from private well No. 6844214 because of its close proximity to Kelly AFB (Figure 2). The water levels from these wells are plotted in Figure 8. Water level readings from Wells 313 and 314 are not available. From this data, ATSDR found that the water levels in the SAWS well J-17 and well 6844214 do not correlate over time. Therefore, ATSDR cannot use either well for determining the water levels in Wells 313 and 314 and could not derive an exposure duration based on this data. Instead, ATSDR derived exposure durations based on the well sampling data discussed in the next section. The differences in water level readings are probably the result of the heterogenous nature of the Edwards aquifer.

DATA EVALUATION AND INTERPRETATION

In this section, data from the Background section is used to formulate exposure levels and durations. The results are then compared to health screening levels.

What contaminants and what concentrations were found in Wells 313 and 314 and the horizontal pipe?

Data for Wells 313 and 314 are presented in Tables 4 and 5, respectively. In Well 313, 1,2-dichloroethane, benzene, chloroform, methylene chloride, tetrachloroethene, and trichloroethene were detected (Table 4). Of these chemicals, 1,2-dichloroethane (43 µg/L) and chloroform (12 µg/L) were the only compounds detected above the screening levels. Tetrachloroethene was detected once in 1988 at 5.5 µg/L which is above EPA's MCL of 5 µg/L.

In Well 314, benzene, chloroform, ethylbenzene, methylene chloride, 1,1,1,2-tetrachloroethane, and 1,1,2-trichloroethane were detected. None of these chemicals exceeded the screening levels (Table 5) or MCLs.

As explained previously, some of these results were determined to be erroneous but were considered in ATSDR's evaluation anyway in order to be more protective of public health.

Of the contaminants that exceeded the screening levels, what concentrations were people exposed to?

Chloroform, 1,2-dichloroethane, and tetrachloroethene were the only compounds that exceeded the screening values or MCLs in the water from Wells 313 and 314. As a result, ATSDR then determined the concentrations of chloroform, 1,2-dichloroethane, and tetrachloroethene that were in the water as it reached the faucets.

Kelly AFB and the state do not sample the water from faucets in offices and on-base housing for volatile organic compounds (VOCs). Sampling for VOCs only occurs at the wells. Therefore, ATSDR took two approaches to calculate the VOC concentrations to which people were exposed. First, ATSDR used the VOC concentrations detected in 1986 and 1988 (12 µg/L chloroform, 43 µg/L 1,2-dichloroethane and 5.5 µg/L tetrachloroethene) in Well 313 and calculated the concentrations after mixing with water from Well 314. Water pumped from Well 313 and Well 314 was mixed together before distribution. Using the annual well production volumes for 1984 (1984 data were used because it resulted in the highest calculated concentrations for comparison, see Table 8 for the data) and assuming the concentration in Well 314 was at the detection level, the water would have been distributed at a concentration of 7.8 µg/L chloroform, 26.8 µg/L 1,2-dichloroethane, and 3.8 µg/L tetrachloroethene (See Appendix C-1). These concentrations would be further reduced as the water combined with water in the distribution system from other production wells. Based on this first dilution, chloroform and tetrachloroethene would be reduced below MCLs and screening values while 1,2-dichloroethane would be above screening values by a factor of four. Looking closer at the 1,2-dichloroethane results, 1,2-dichloroethane was detected twice in January 22, 1986 when Well 313 was sampled 5 times. In fact, two samples were collected on January 22, 1986. One sample contained 43 µg/L 1,2-dichloroethane but the second sample, 1,2-dichloroethane was not detected. In March

gpm to 0.0000015 gpm per foot per side of Leon Creek.

From these numbers, the potential amount of water discharging into the pipe could be as much as 50 gpm (theoretical maximum) or as low as 0.0000015 gpm. If 50 gpm is used (based on the pumping rate), one must consider that this flow rate is the cumulative flow rate from the entire well screen. If a 10-foot well screen is assumed, the flow rate is about 5 gpm per foot of screen length. This value doesn't include the possibility of the screen being exposed to the unsaturated zone due to the cone of depression, which would increase the flow rate per foot of screen length. It also doesn't consider the total exposed surface area of the screen. For example, a one foot section of screen, 2 inches in diameter, would have an exposed surface of about 0.5-square feet. This is equivalent to a hole in the horizontal pipe 8.6 inches by 8.6 inches (not including the area occupied by the screen which could be more than one-half the exposed surface).

Assuming that the leak in the horizontal pipe is similar to one foot of screen length in the pipe, 10 gpm is flowing into the pipe. Using 10 gpm containing a concentration of 100 µg/L tetrachloroethene and 10 µg/L trichloroethene, combining with water from the Edwards aquifer with concentrations at the detection level of 1 µg/L, the concentration of water coming out of Well 313 would be 3.26 µg/L tetrachloroethene and 1.21 µg/L trichloroethene (See Appendix C, these calculations used the 1983 production data because it produced the highest concentrations for comparison).

If 50 gpm is used as the amount of water entering Well 313 from the horizontal pipe, which is unlikely, the concentration of water coming from Well 313 would be 12.3 µg/L tetrachloroethene and 2.03 µg/L trichloroethene. Mixing this water from Well 314, the concentrations would be 5.57 µg/L for tetrachloroethene and 1.42 µg/L for trichloroethene. These values are below the health screening values of 55 µg/L tetrachloroethene and 80 µg/L trichloroethene. The value of 5.57 µg/L tetrachloroethene is slightly above the MCL, but it is based on the 50 gpm of water entering the horizontal pipe, which is a high end estimate. When 50 gpm drops to 43.8 gpm, the concentration of tetrachloroethene would become 5.0 µg/L. This high end estimate of 50 gpm is not likely. Lower flow rates, lower than 43.8 gpm, are more likely.

Conclusion

Based on our calculated concentrations, flow rates from the horizontal pipe, and assumptions presented in the previous section, the water entering Well 313 from the horizontal pipe did not contaminate the well water at levels of public health concern. High end estimates indicate that the concentration could possibly have been above MCLs, but it is very unlikely. Concentrations measured in Well 313 were not reproducible and not consistent. If a chemical was present, the reported concentration was at relatively low levels and present for a short period of time. *Hence, past exposures from potable use of water from Well 313 and 314 pose no apparent public health hazard.* The exposure pathway is summarized in Table 9.

SAIC 1996. Technical Report, Investigation and Abandonment of Edwards Wells, I-65, I-69, I-75, I-76, I-80, and I-99, Science Applications International Corporation, September 1996.

SAIC 1997. Technical Report, Investigation, Location, and Abandonment of Edwards Wells, I-72, I-74, I-80, Science Applications International Corporation, February 1997.

Texas Water Development Board 2000. Well Information
http://www.twdb.state.tx.us/Newwell/well_info.html, accessed February 2000.

U.S. Geological Society 1997. Water Quality Assessment of South-Central Texas--Occurrence and Distribution of Volatile Organic Compounds in Surface Water and Ground Water, 1983-1994, and Implications for Future Monitoring, by Patricia B. Ging, Linda J. Judd, and Kirby H. Wynn. Water-Resources Investigations Report 97-4028.

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Table 1. Production/Drinking Water Well Information, Kelly Air Force Base.

New Well Number (Same as Building Number)	Old Base Well Number	"I" Series Well Number	USGS Well Number	Year Drilled	Date Plugged	Total Depth (feet)	Max* (gpm)	Production for 7/88 (1000 gallons)	Comment
81	-	-	-	1994	na	1,500	2,200	0	Replacement for wells 141 and 313.
141	3	96	810	1906	6/20/91	1,400	900	0	Out of service since 1984.
313	2	124	808	1910	6/26/91	1,590	1,050	36,535	7/7/88: 5.5 µg/L PCE detected. 9/23/88: No VOCs detected. 1/31/89: Well 313 is taken out of service. 6/23/89: Horizontal pipe found with 52 µg/L PCE. 7/17/89: Gap in well at 590 feet. 3/26/91: Determined pipe comes from shallow aquifer. 6/26/91: Plug placed in pipe over horizontal pipe. 6/16/91: Well 313 is cemented and permanently sealed.
314	4	97	809	1940	6/21/98	1,608	1,500	28,289	7/7/88, 8/11/88, 9/23/88, 7/14/89, 9/6/89, 10/12/89: No contaminants detected. 2/1/90: Detected very low levels of chlorinated solvents. 3/6/90: Horizontal pipe found. 4/11/90: A patch is placed over the horizontal pipe as a precaution. 6/21/98: Well is cemented and sealed.
1040	-	-	-	1996	na	1,560	800	0	Replacement for well 1044.

Table 2. Irrigation Wells at Kelly Air Force Base.

"I" Series Well Number	Year Drilled	Date Plugged	Comment
65	1912	See Comment	Inactive and abandoned. " Kelly AFB could not locate this well and records do not exist. May be covered by Taxiway 3B.
69	1924	1996	No comments.
72	Possibly in the 1930s	1997	No comments.
73	1933	1997	No comments.
74	Unknown	1998	No comments.
75	Early 1930s	Unknown	Abandonment confirmed by Kelly AFB in 1996
76	1913	Unknown	Abandonment confirmed by Kelly AFB in 1996.
80	<1934	Unknown	Abandonment confirmed by Kelly AFB in 1996.
99	1912	1996	No comments.

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Table 3. Production/drinking water well monitoring data (1983 -1998)¹, volatile organic compound concentration (µg/L) by production well, Kelly Air Force Base (continued).

Chemical	Well 141	Well 313	Well 314	Well 1044	Well 1536	Well 1556	Well 3010	Well 1638	EPA MCL or LTHA (µg/L)	EPA RBCs (6 Years of Exposure at 1/100,000) (µg/L)
Methylene chloride	0.5 - 1.6 (2/6)	0.5 - 5 (2/9)	2.1 (1/9)	1.1 - 3.8 (2/11)	1.7 - 2.3 (2/10)	1.3 - 1.4 (2/8)	1.3 (1/11)	2.4 (1/11)	5	215 c 1600 nc
1,1,1,2-Tetrachloroethane	0.08 (1/6)	nd (0/9)	4.7 (0/9)	nd (0/12)	nd (0/11)	nd (0/8)	nd (0/11)	nd (0/11)	no value	21.5 c 180 nc
Tetrachloroethene	nd (0/6)	0.12 - 5.5 (4/9)	nd (0/10)	0.2 (1/13)	nd (0/7)	nd (0/7)	nd (0/8)	nd (0/6)	5	55 c 250 nc
1,1,1-Trichloroethane	1.8 (1/6)	1.2 (1/9)	2.7 (1/11)	nd (0/12)	2.5-2.6 (2/11)	1-1.8 (3/8)	2 (1/11)	2.5 (1/11)	200	790 nc
1,1,2-Trichloroethane	nd (0/6)	nd (0/9)	0.6 (1/9)	nd (0/12)	nd (0/11)	nd (0/8)	nd (0/11)	nd (0/11)	5	10 c 24 nc
Trichloroethene	nd (0/6)	nd - 2.8 (2/9)	nd (0/10)	2.2 (1/13)	nd (0/7)	nd (0/6)	nd (0/8)	nd (0/5)	5	80 c 35 nc

Notes:

(1) Data collected by OEHL (11/23/83, 4/15/85, 1/22/86, 3/11/86, 5/15/86); Radian (1/22/86, 4/16/86); TDH (7/7/88, 12/01/93, 3/24/94, 7/8/94, 12/03/96, 11/0-3/97); and LCRA (8/14/94, 11/30/95); TWC (12/01/93); TNRCC (2/12/98).

Key: c Cancer

nc noncancer

EPA RBCs EPA Region 6 Risk Based Concentrations based on 30 years of exposure 24 hours a day, 350 days per year.

LCRA Lower Colorado River Authority

LTHA Lifetime Health Advisory for drinking water

MCL EPA's maximum contaminant level

nd not detected

Table 4. Production/drinking Water Well Monitoring Data (1983-1988), Volatile Organic Compound Concentration for Well 313, Kelly Air Force Base

Chemical	Organization Collecting and Analyzing Sample with Month and Year of Sample												EPA RBCs (6 Years of Exposure at 1/100,000) (µg/L)		
	Sampling as part of the SDWA			Sampling as part of the IRP program										Sampling as part of the SDWA	
	OEHL 11/83	OEHL 4/85	Radian 1/86	OEHL 1/86	OEHL 3/86	OEHL 3/86 (split)	OEHL 4/86	OEHL 5/86	TDH 7/88	TDH 9/88	EPA MCL or LTHA (µg/L)				
1,2-Dichloroethane	ND	NS	ND	43	3	2.1	ND	ND	<1.0	<1.0	5	6 c 17 nc			
1,3-Dichlorobenzene	ND	NS	ND	ND	ND	ND	ND	ND	<1.0	<1.0	600 LTHA	17 nc			
1,4-Dichlorobenzene	ND	NS	ND	ND	ND	ND	ND	ND	ND	<1.0	75	24 c 1400			
Benzene	ND	NS	3.87	ND	ND	ND	ND	ND	<0.1	<0.1	100	21 c 11 nc			
Chlorobenzene	ND	NS	ND	ND	ND	ND	ND	ND	<0.1	<0.1	no value	39 nc			
Chloroform	ND	NS	ND	12	1	ND	ND	ND	<0.1	<0.1	700	8 c 61 nc			
Ethylbenzene	ND	NS	ND	ND	ND	ND	ND	ND	<2.0	<2.0	5	1300 nc			
Methylene chloride	ND	NS	ND	5	0.5	ND	ND	ND	<0.1	<0.1	5	215 c 1600 nc			
Tetrachloroethene	ND	NS	0.34	0.6	ND	ND	0.12	ND	5.5	<0.1	5	55 c 250 nc			
1,1,1-Trichloroethane	ND	NS	ND	ND	2.1	ND	ND	ND	<1.0	<1.0	200	790 nc			
Trichloroethene	ND	NS	ND	2.8	ND	ND	ND	ND	<0.1	<0.1	5	80 c 35 nc			

Key: Source: Kelly AFB.

ND= not detected

NS = not sampled

µg/L = micrograms per liter

RBC= risk based concentration

SDWA = Safe Drinking Water Act

TDH= Texas Department of Health

OEHL= Occupational Environmental Health Laboratory, U.S. Air Force

LTHA = U.S. EPA lifetime health advisory for drinking water

IRP = Installation Restoration Program

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Table 5. Production/drinking Water Well Monitoring Data (1983-1998), Volatile Organic Compound Concentration for Well 314, Kelly Air Force Base (continued).

Organization Collecting and Analyzing Sample with Month and Year of Sample																
Chemical	Sampling as part of the SDWA		Sampling as part of the IRP program							Sampling as part of the SDWA						EPA RBCs (6 Years of Exposure at 1/100,000) (µg/L)
	OEHL 11/83	OEHL 4/85	Radian 1/86	OEHL 1/86	OEHL 3/86	OEHL 4/86	OEHL 5/86	TDH 7/88	TDH 9/88	2/90 *	TWC /93	TDH 3/94	TDH 12/96	TNRCC 2/12/98	EPA MCL or LTHA (µg/L)	
1,1,1,2-Tetrachloroethane	ND	NS	ND	ND	ND	ND	ND	NS	NS	4.7	NS	NS	NS	<0.5	no value	21.5 c 180 nc
Tetrachloroethene	<0.2	NS	ND	ND	ND	ND	ND	<0.001	<0.001	ND	NS	NS	NS	<0.5	5	55 c 250 nc
1,1,1-Trichloroethane	ND	NS	ND	ND	ND	ND	ND	<0.001	<0.001	ND	NS	<0.5	NS	<0.5	200	790 nc
1,1,2-Trichloroethane	ND	NS	ND	ND	ND	ND	ND	NS	NS	0.6	NS	NS	NS	<0.5	5	10 c 24 nc
Trichloroethene	ND	NS	ND	ND	ND	ND	ND	<0.001	<0.001	ND	NS	NS	NS	<0.5	5	80 c 35 nc

Key: Source: Kelly AFB no date.

ND= not detected

NS = not sampled

OEHL= Occupational Environmental Health Laboratory

U.S. Air Force

$\mu\text{g/L}$ = Micrograms per liter

LTHA = U.S. EPA lifetime health advisory for drinking water

RBC= risk based concentration

TDH= Texas Department of Health

TNRCC = (Texas Natural Resources and Conservation Commission)

TWC = Texas Water Commission

* = Organization collecting and analyzing sample not reported (Gargiulo 1998).

IRP = Installation Restoration Program

SDWA = Safe Drinking Water Act

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Table 6. Production/drinking Water Well Monitoring Data (1983 -1995), Volatile Organic Compound Concentration (µg/L) for Well 1044, Kelly Air Force Base (continued).

Chemical	Organization Collecting and Analyzing Sample with Month and Year of Sample														
	Sampling as part of the SDWA			Sampling as part of the IRP program											
	Sampling as part of the SDWA														
	OEHL 11/83	Radian 1/86	OEHL 1/86	OEHL 3/86	OEHL 3/86 (split)	OEHL 4/86	OEHL 5/86	TDH 7/88	TDH 12/93	TDH 3/94	TDH 7/94	LCRA 8/95	LCRA 11/95	EPA MCL or LTHA (µg/L)	EPA RBCs (6 Years of Exposure at 1/100,000) (µg/L)
Tetrachloroethene	ND	ND	0.2	ND	ND	ND	ND	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	5	55 c 250 nc
1,1,1-Trichloroethane	ND	NS	ND	ND	2.1	ND	ND	<1.0	NS	<0.5	<0.5	<0.5	<0.5	200	790 nc
Trichloroethene	ND	ND	2.2	ND	ND	ND	ND	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	5	80 c 35 nc

Key: Source: Kelly AER no data

Key: Source: Kelly AFB no date.

ND= not detected

NS = not sampled

OEHL= Occupational Environmental Health Laboratory

µg/L = micrograms per liter

SDWA = Safe Drinking Water Act

* =

No human health based screening levels were available for 2-chloroethylvinyl ether. This value is the surface water screening values derived by U.S. EPA Region 4 Water Management Division. These values were obtained from Water Quality Criteria documents and represent the chronic ambient water quality criteria values for the protection of aquatic life.

TDH= Texas Department of Health
TNRCC = (Texas Natural Resources and Conservation Commission)
TWC = Texas Water Commission
IRP = Installation Restoration Program

Table 7. Selected history of Wells 313 and 314, Kelly Air Force Base (continued).

Date	Well	Event
06/23/89	313	<p>In response to the sound of running water in the well casing on 6/22/89, a TV study was conducted and revealed a 12" diameter horizontal pipe about 30 feet deep running into the well's casing at 31 feet below ground level. The pipe was formerly used to convey water under artesian pressure from the well to a distribution system located between Wells 313 and 314; during the 1970s, pumps were installed in the two wells, and the distribution system was shut down and associated pipes reportedly capped.</p> <p>A sample of the water running from this pipe was collected; results revealed that it contains 52 µg/L of PCE. However, this concentration is not considered precise because of the way the instruments used were calibrated. Levels of other chlorinated solvents were not measured in the sample. Metal levels were below detection limits. No information about how long the pipe has been present or how it was used is available.</p>
06/26/89	313	KAFB has a three-foot plug placed in front of the horizontal pipe to prevent water in the pipe from entering the production well.
07/14/89	314	KAFB sampled Well 314 for parameters that include VOCs, and no contaminants were measured above detection limits.
07/17/89	313	An additional TV study shows a one-foot gap in the well at a depth of 590 feet.
09/01/89	313	A letter from "MFR" raises questions about the source of contamination in Well 313 and whether contamination might be a problem elsewhere in the base's water supply system.
09/06/89	314	KAFB samples Well 314 for metals and related parameters; no constituents were detected at levels of concern.
10/12/89	314	KAFB samples Well 314 for parameters that include VOCs, and no contaminants are measured above detection limits.
10/13/89	313	Fuel contamination was reported in an IRP monitoring well near Well 313.
02/01/90	314	Samples collected from Well 314 do not contain detectable concentrations of any regulated analytes, but certain chlorinated solvents were detected at low levels, below or slightly exceeding ATSDR's most conservative comparison values.
03/06/90	314	a horizontal pipe similar to the one discovered entering Well 313 was reported present in this well. Although no water is observed entering the well from the pipe, it is not known whether this may have occurred in the past.

Table 8. Well Production for 1983 and 1984 in 1000 gallons.¹

Well Production in 1983 per 1000 gallons								
Well Number	313	141	314	1638	1556	1044	3010	1536
January	3210	27108	42405	0	1272	9055	15639	0
February	1446	28836	38742	0	10776	6600	2952	0
March	692	31455	36969	0	23472	8183	4056	0
April	819	32395	32091	0	22560	12845	14340	0
May	2172	33939	35132	0	16464	12206	22269	0
June	28126	24408	22454	0	22704	11513	17316	0
July	32975	30159	15103	0	23520	12659	18681	0
August	30677	33696	24259	0	27024	13541	16731	0
September	34551	10470	27521	0	23376	12735	24258	0
October	38177	5130	29132	0	16824	13834	20358	0
November	28440	20898	17696	0	16272	4176	19656	0
December	29021	19431	18288	0	17634	264	19278	0
Annual total	230306	297925	339792	0	221898	117611	195534	0
Average per month	19192	24827	28316	0	18492	9801	16294	0
Average gallons per minute	437	565	645	0	421	223	371	0
Ratio 313/314	0.68							

Well Production in 1984 per 1000 gallons								
	313	141	314	1638	1556	1044	3010	1536
January	33741	20637	10911	0	16828	1574	7227	11104
February	29452	16838	10068	0	10549	5185	5432	11961
March	34412	27290	17658	0	8120	11570	5685	7478
April	33967	28133	25401	0	8515	13135	9459	8726
May	38015	34398	28465	0	8841	11014	11108	15792
June	38019	36805	32150	0	17003	11551	14908	5696
July	39808	37044	32992	0	11426	14797	33933	0
August	36057	36045	30060	0	13696	14951	18262	17016
September	37247	25723	17527	11760	6660	12482	11054	15875
October	37053	10071	19805	22419	7638	4639	1595	12734
November	33719	0	16343	16416	14072	8333	14615	2613
December	33125	0	25643	11090	11716	3378	8089	15913
Total	424615	272984	267023	61685	135064	112609	141367	124908
Average per month	35385	22749	22252	5140	11255	9384	11781	10409
Average gallons per minute	806	518	507	117	256	214	268	237
Ratio 313/314	1.59							

¹ ATSDR obtained and reviewed the production well data for years 1983 through 1988. 1983 was the year Kelly AFB began sampling the wells and 1988 is the year that Well 313 was discontinued. The production volumes change from year to year so the calculated concentrations would also change depending on the relative production from Wells 313 and 314. For the calculated concentrations, ATSDR used the values that produced the highest concentrations to be more protective of public health in this evaluation. In these cases, 1983 produced the highest concentrations in the calculations in Appendix C-1 and 1984 produced the highest concentrations in the calculation in Appendix C-2.

Figure 2. Well inventory in Bexar County, Texas.

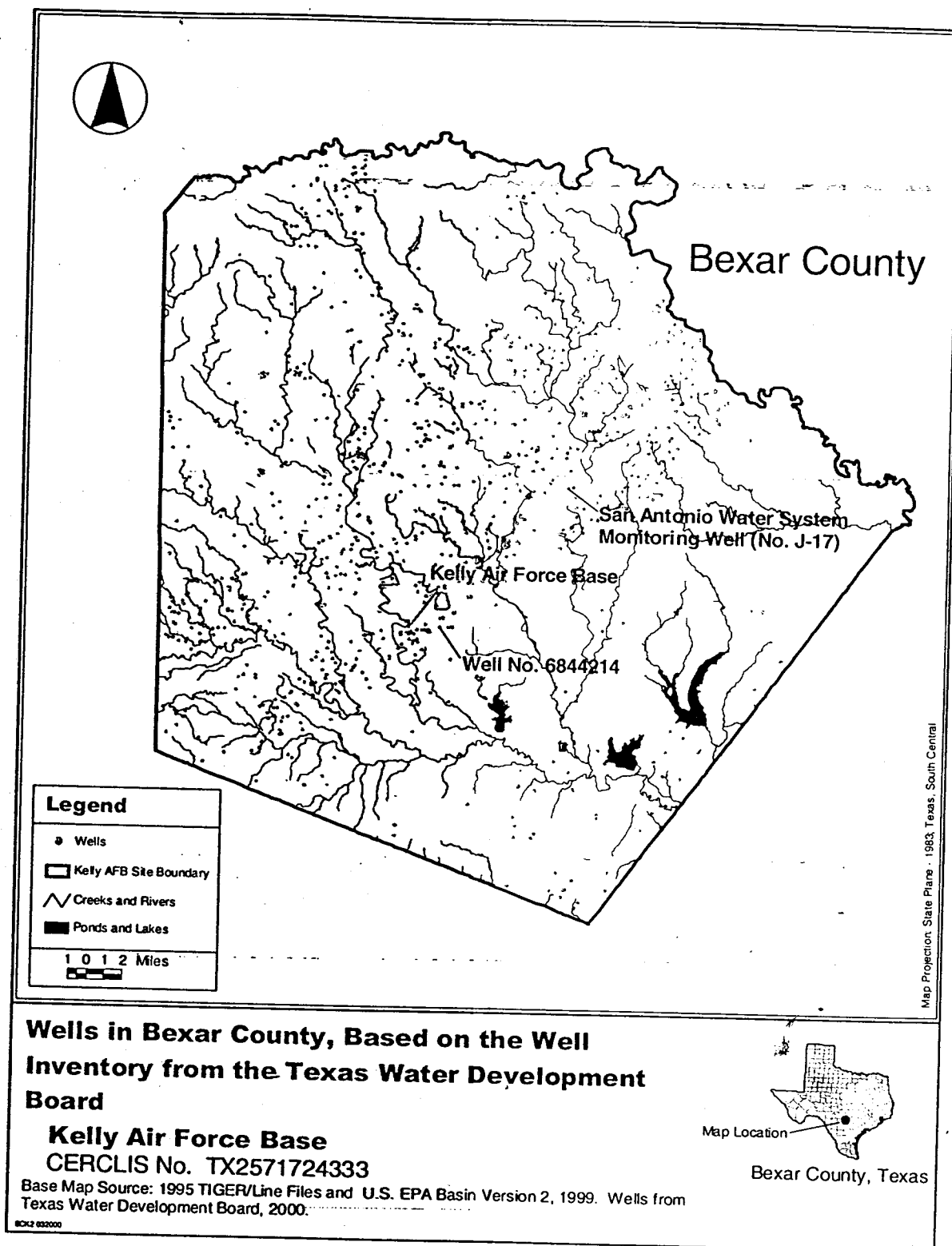


Figure 3. Drinking water/production wells 313 and 314, IRP monitoring wells, and shallow groundwater information.

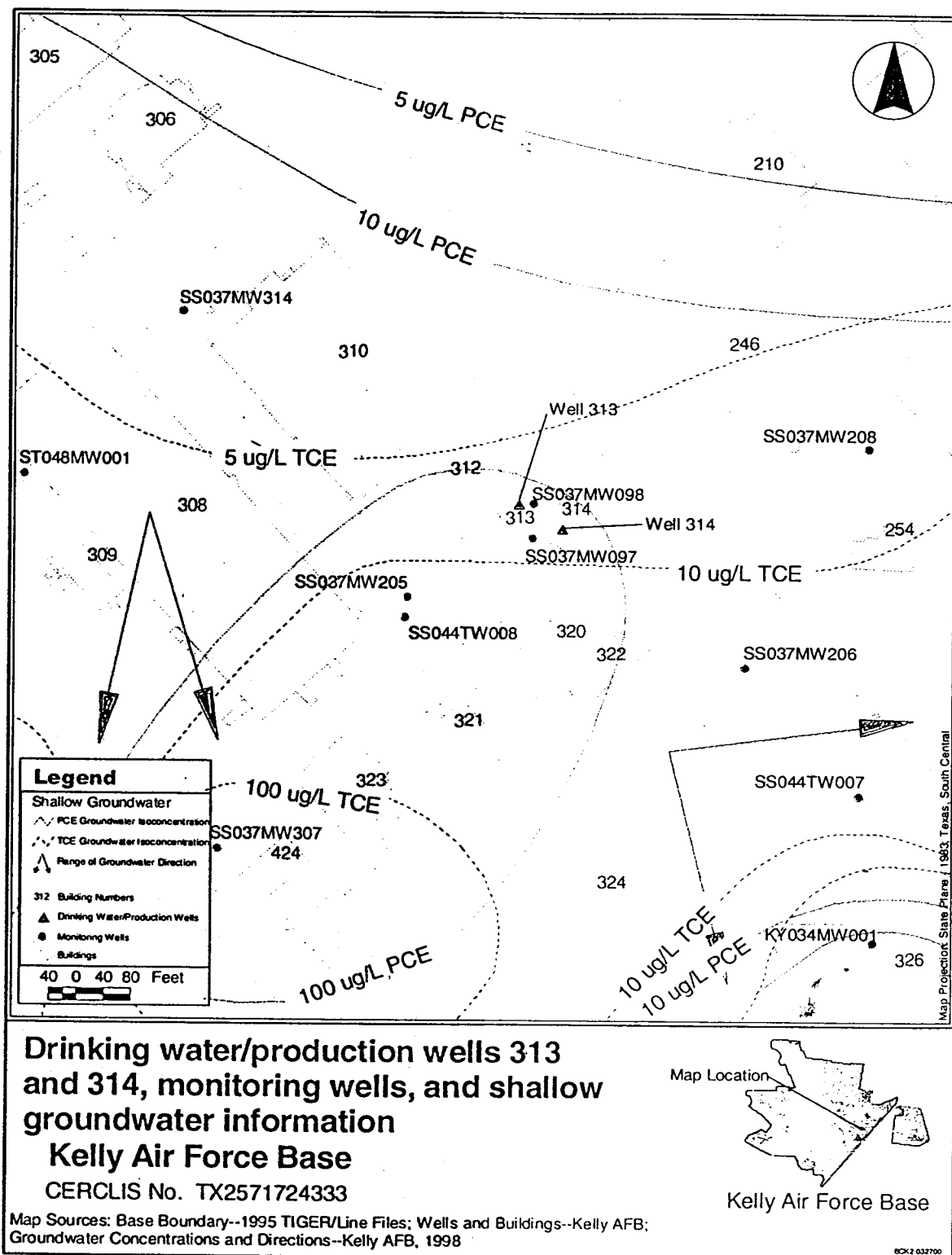
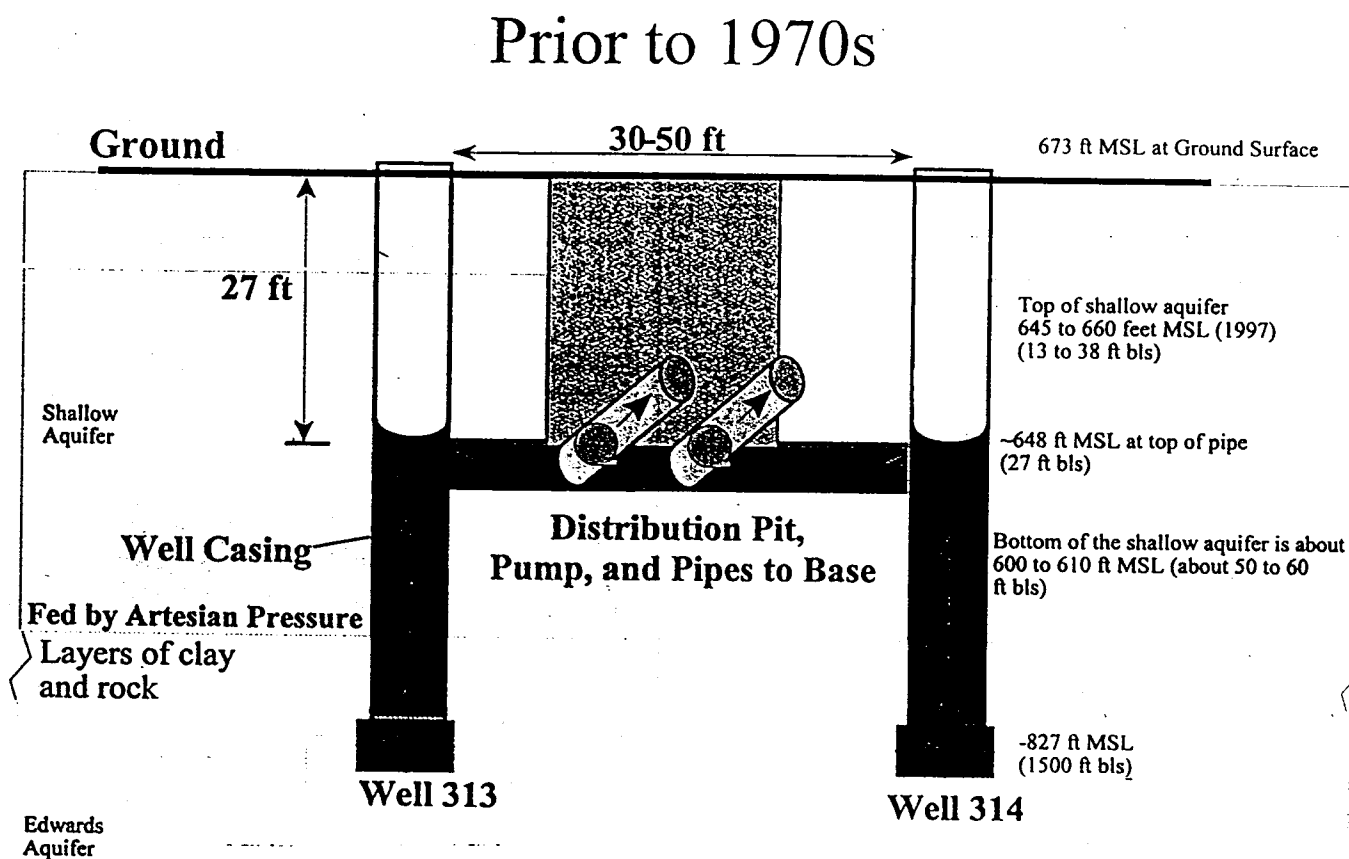


Figure 4. Simplified schematic of Wells 313 and 314 with horizontal pipe when pumps were located out of the wells.

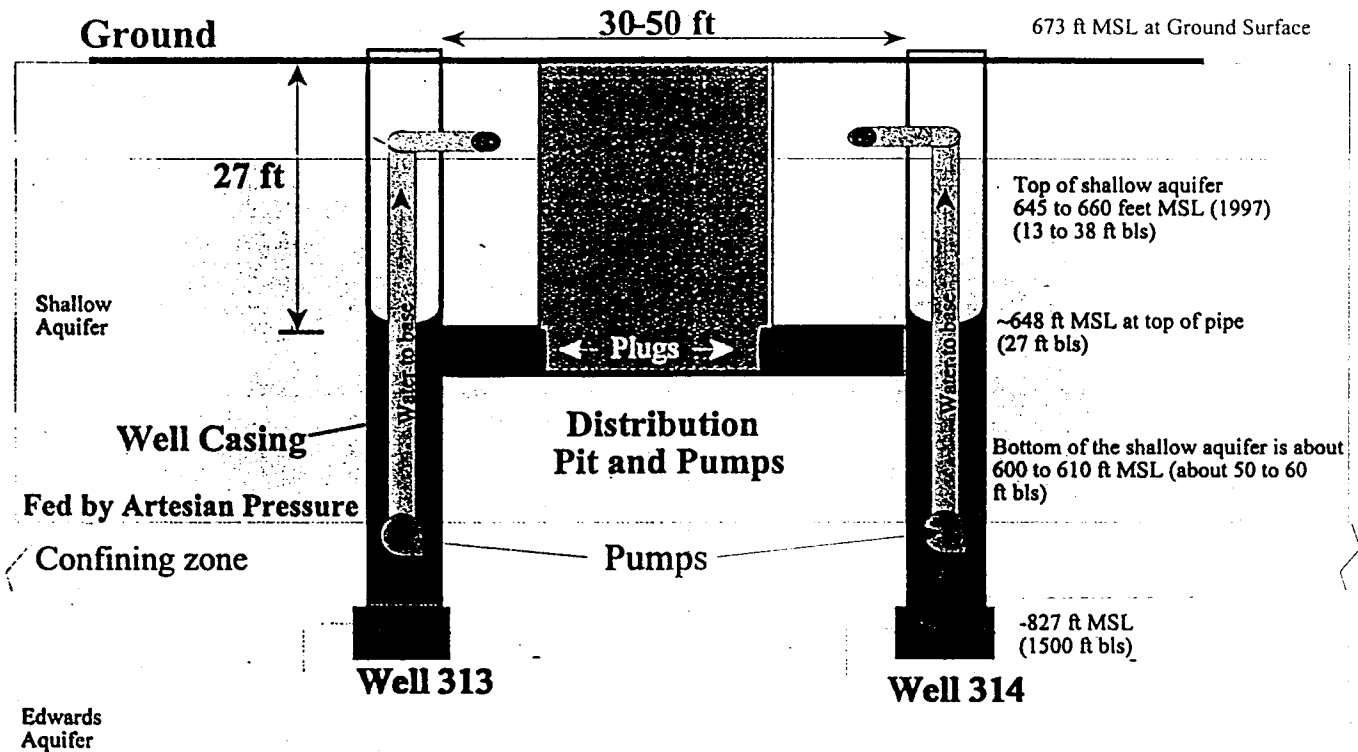


bls – below ground surface
MSL – mean sea level

Based on a drawing from Gargiulo (1998).

Figure 5. Simplified schematic of Wells 313 and 314 with horizontal pipe after pumps were moved to the wells with no leak in the horizontal pipe.

1970s to 1980s

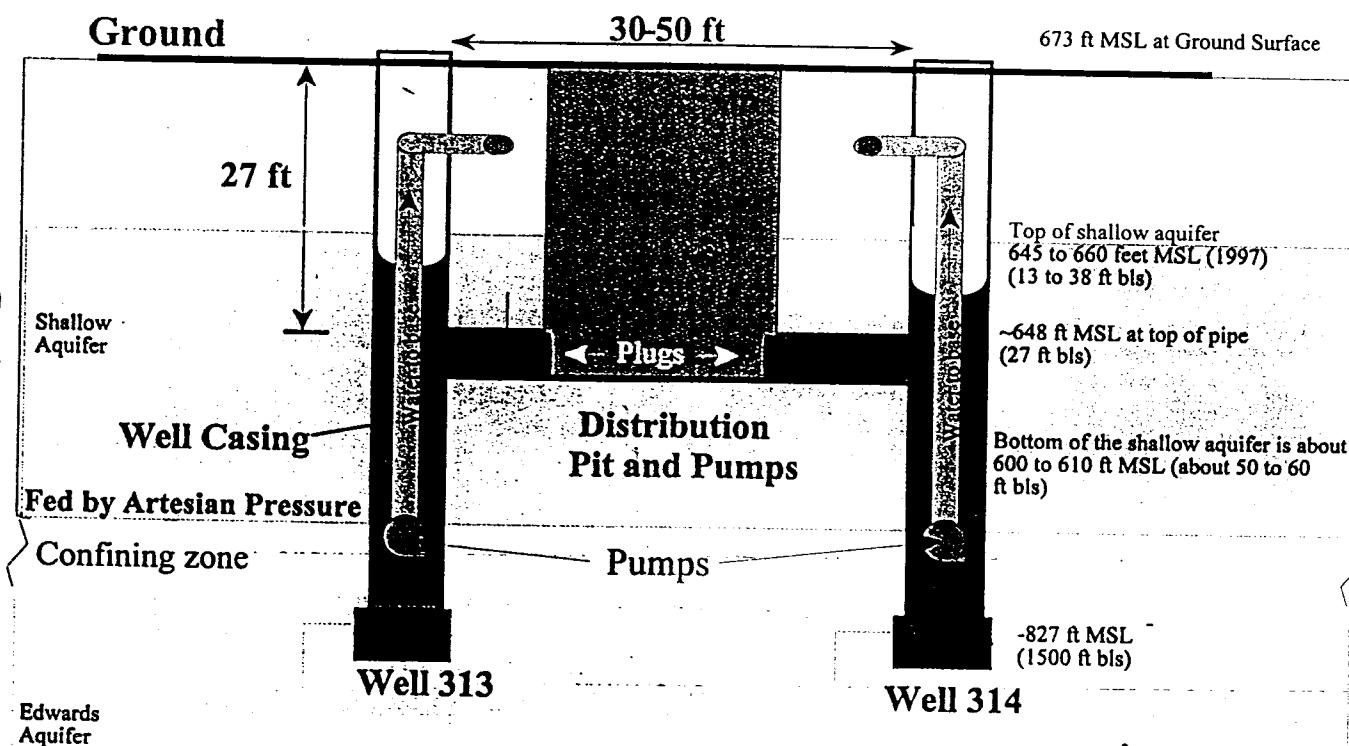


bls – below ground surface
MSL – mean sea level

Based on a drawing from Gargiulo (1998).

Figure 6. Simplified schematic of Wells 313 and 314 with a leak in the horizontal pipe and relative low water level in the Edwards aquifer. As a result of the greater hydrostatic pressure in the shallow aquifer compared to the Edwards aquifer, water will flow from the shallow aquifer through the leak into the horizontal pipe and well casing and mix with water up welling from the Edwards aquifer.

1970s to 1980s - Low Level Edwards Aquifer

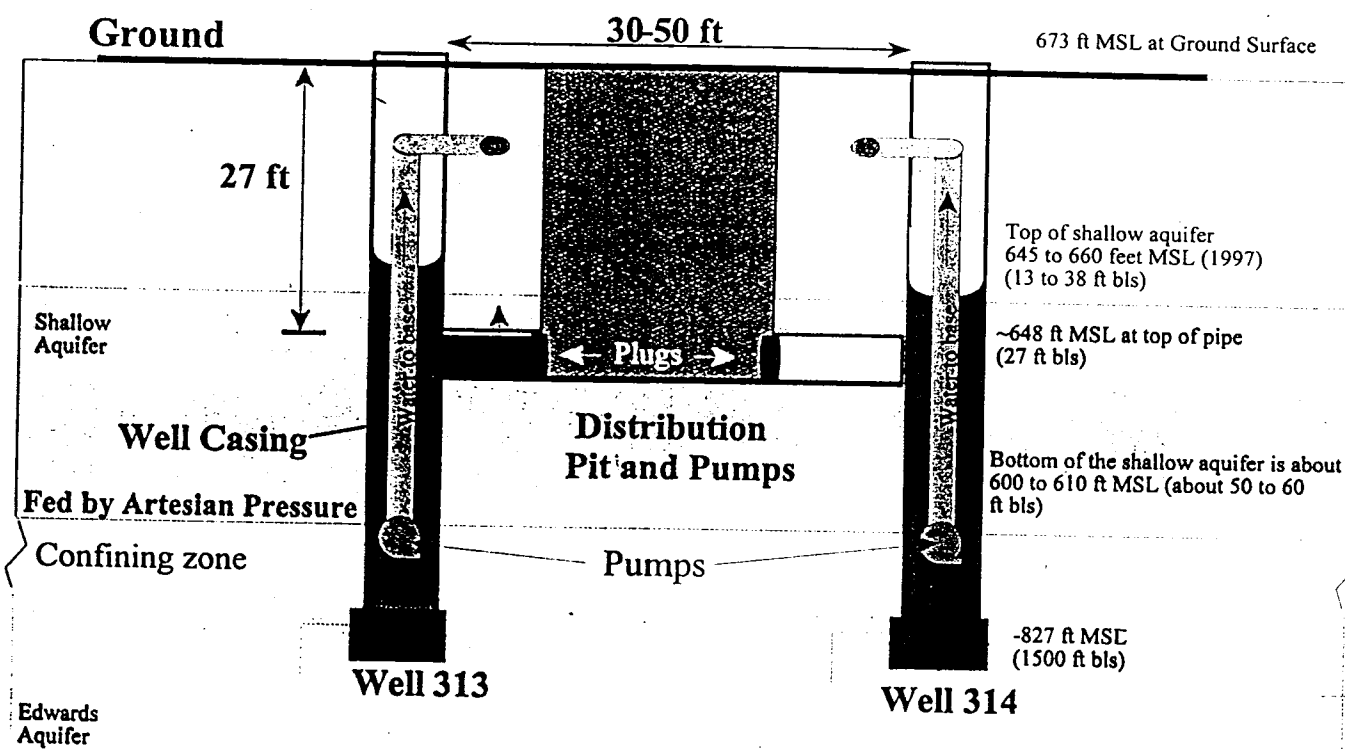


bls – below ground surface
MSL – mean sea level

Based on a drawing from Gargiulo (1998).

Figure 7. Simplified schematic of Wells 313 and 314 with a relative high water level in the Edwards aquifer. As a result of the greater hydrostatic pressure in the Edwards aquifer compared to the shallow aquifer, water will flow from the Edwards aquifer through the well casing into the horizontal pipe, through the leak and into the shallow aquifer.

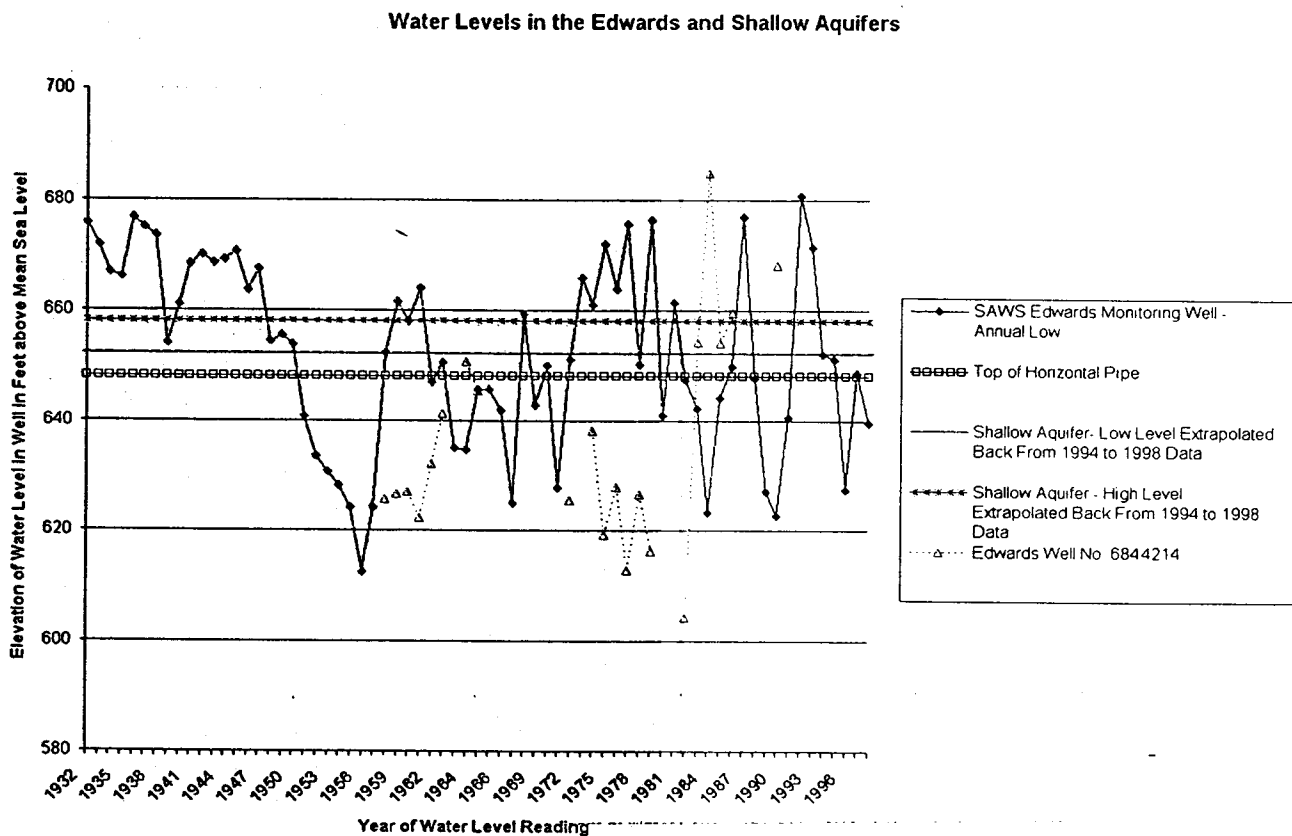
1970s to 1980s - High Level Edwards Aquifer



bls – below ground surface
 MSL – mean sea level

Based on a drawing from Gargiulo (1998).

Figure 8. Water level readings from the San Antonio Water System Edwards aquifer monitoring well (J17) and private well number 6844214 in relation to the shallow aquifer water levels and the depth of the horizontal pipe.



Appendix A. Screening Values

Screening values were obtained from U.S. EPA Region 6 (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and modified to site-specific exposure conditions and risk levels. Only cancer screening values were modified. EPA Region 6 cancer screening values are based on 30 years exposure as an adult and a target risk of 1/1,000,000. ATSDR modified the cancer screening values to 6 years and target risk of 1/100,000 by multiplying the screening values by 50; 5 for the conversion from 30 to 6 years and 10 for the conversion from 1/1,000,000 to 1/100,000. The 6 years is based on the 6 years of exposure discussed in the Data Evaluation and Interpretation Section of this consultation. Because the U.S. EPA Region 6 cancer screening values were based on 6 years as a child and 24 years as an adult, the conversion includes child and adult exposures. The conversion from 1/1,000,000 to 1/100,000 is based on the following ATSDR cancer risk categories in which 1/100,000 is considered no apparent increased risk of cancer as shown below.

Category Definitions of Cancer Risk

Category	Fraction	Decimal	Exponential
No Increased Risk	<1/100,000	<0.00001	<1E-05
No Apparent Increased Risk	1/100,000	0.00001	1E-05
Low Increased Risk	1/10,000	0.0001	1E-04
Moderate Increased Risk	1/1,000	0.001	1E-03
High Increased Risk	1/100	0.01	1E-02
Very High Increased Risk	>1/100	>0.01	>1E-02

Note: Category definitions used by ATSDR are intended to define categories of estimated risk to convey the degree of hazard from the defined exposure relative to other exposures. Categories are derived from ATSDR Decision Statement TOX:14. Draft QAA-27. Revised October 21, 1991.

Appendix C. Calculations

Appendix C-1. Calculation of concentration in water combined from Wells 313 and 314 using 1984 production data because it provides the highest concentrations for this calculation.

Chloroform

$$\frac{806 \text{ gpm} (12 \mu\text{g/L}) + 507 \text{ gpm} (1 \mu\text{g/L})}{806 \text{ gpm} + 507 \text{ gpm}} = 7.8 \mu\text{g/L}$$

1,2-Dichloroethane

$$\frac{806 \text{ gpm} (43 \mu\text{g/L}) + 507 \text{ gpm} (1 \mu\text{g/L})}{806 \text{ gpm} + 507 \text{ gpm}} = 26.8 \mu\text{g/L}$$

Tetrachloroethene

$$\frac{806 \text{ gpm} (5.5 \mu\text{g/L}) + 507 \text{ gpm} (1 \mu\text{g/L})}{806 \text{ gpm} + 507 \text{ gpm}} = 3.8 \mu\text{g/L}$$

* When not reported, 1 $\mu\text{g/L}$ is assumed to be the detection limit.

Appendix C-2. Calculation of concentration of well water with shallow aquifer water at 100 $\mu\text{g/L}$ and 10 $\mu\text{g/L}$ flowing into the well at 10 gpm and 50 gpm, using 1983 production data because it provides the highest concentrations for this calculation.

- Water from Well 313 combining with water from the shallow aquifer at 10 gpm

$$\frac{(1 \mu\text{g/L} \times (437 \text{ gpm} - 10 \text{ gpm})) + (100 \mu\text{g/L} \times 10 \text{ gpm})}{437 \text{ gpm}} = 3.26 \mu\text{g/L tetrachloroethene}$$

$$\frac{(1 \mu\text{g/L} \times (437 \text{ gpm} - 10 \text{ gpm})) + (10 \mu\text{g/L} \times 10 \text{ gpm})}{437 \text{ gpm}} = 1.21 \mu\text{g/L trichloroethene}$$

- Combining with Well 314

$$\frac{437 \text{ gpm} (3.26 \mu\text{g/L}) + 645 \text{ gpm} (1 \mu\text{g/L})}{437 \text{ gpm} + 645 \text{ gpm}} = 1.92 \mu\text{g/L tetrachloroethene}$$

$$\frac{437 \text{ gpm} (1.21 \mu\text{g/L}) + 645 \text{ gpm} (1 \mu\text{g/L})}{437 \text{ gpm} + 645 \text{ gpm}} = 1.19 \mu\text{g/L trichloroethene}$$

Appendix D. Information about the Edwards aquifer.

To understand the Edwards aquifer, one must understand how the aquifer was formed and how water is transmitted through it. The formation of the Edwards aquifer began around 100 million years ago when the ocean periodically covered southeastern Texas. When southeastern Texas was covered by the ocean, sediments from the water settled to the bottom and formed the Edwards aquifer. During times when the ocean receded, erosion occurred creating cavities and conduits making the Edwards aquifer capable of holding and transmitting water. At some point, the sediments settling on the ocean floor changed from limestone forming materials to clays that were relatively impermeable to water. These clays formed a confining unit which prevented water from seeping into the Edwards aquifer from above.

Beginning about 70 million years ago, mountains west of San Antonio began forming by thrusting up. Related to this activity, millions of tons of sediments, carried by the wind and water, started to deposit on Texas. The formation of these sediments resulted in a thicker layer of sediment towards the coast. The tremendous weight of the sediments caused a series of parallel faults in the Edwards aquifer. As a result of the thrust and sediments, the limestone layers that had been laid down flat became tilted with a section of the Edwards aquifer exposed at the surface in an area known as the Balcones Fault Zone. This zone, north and west of San Antonio, is a 1,500 square mile area, that allows large quantities of water to flow into the aquifer. Once the Edwards aquifer dips below the ground surface, the soils above the aquifer prevent surface water from migrating into it under natural conditions. Under Kelly AFB, the aquifer is 1,500 feet below the ground surface.

This information was obtained from <http://www.edwardsaquifer.net/geology.html>.